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(54) Treatment of compact discs.

(57) A method for removing lacquer and aluminium coatings from polycarbonate substrates of scrap compact discs, so as to reclaim the polycarbonate, includes immersing the discs in an alkaline solution, heating the solution to a predetermined temperature, and mechanically agitating the immersed discs by applying ultrasonic energy to the solution at a sufficient energy density and for a sufficient time to dissolve the lacquer and the aluminium into the solution. The solution containing the dissolved lacquer and aluminium is decanted from the stripped polycarbonate discs, and the discs are washed with water to remove remanent alkaline solution and then dried.

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This invention relates to the treatment of compact discs.

As is well known, the compact disc is becoming an increasingly popular medium for the replication of, among other things, audio programmes. As currently manufactured, the compact disc comprises a thin circular polycarbonate substrate approximately 121 mm (4.75 inches) in diameter and having a central aperture designed to be received on a centring mechanism of a disc player. Usually, the disc incorporates digitally encoded information on one surface thereof which is designed to be laser-read by the disc player. The information-bearing surface of the substrate is coated with a thin film of aluminium which, in turn, is covered with a protective lacquer coating, of which two types are currently in common use. One is cellulose-nitrate-based material in a suitable solvent such as toluene (so-called solvent-based lacquer) and the other is an ultra-violet-cured acrylic-based material. Information regarding the programmes recorded on the disc is printed in ink on the lacquer coating.

In the course of manufacture and distribution of such compact discs, many are scrapped as production rejects, or as a consequence of returns and inventory obsolescence, which presents a serious problem of disposal. Currently, they are either sold for scrap polycarbonate at a price which is very low (currently about US$ 0.022 per kg (US$ 0.01 per pound)) because of contamination by the coatings or, if not salable at any price, discarded in a landfill. If the coatings are removed, the polycarbonate is more salable in that it can be re-used for the fabrication of compact discs or other parts and fetches a reasonable price, currently US$ 0.53 per kg (US$ 0.24 per pound), which at the same time eliminates the need to landfill the scrapped discs.

According to one aspect of the invention there is provided a process for the treatment of compact discs to remove the coatings therefrom to free the polycarbonate substrate, the process comprising the steps of mechanically agitating the discs with ultrasonic energy while they are immersed in a heated alkaline solution until the coatings are stripped from the substrate, and then rinsing and drying the stripped polycarbonate discs.

According to a second aspect of the invention there is provided a method for removing lacquer and aluminium coatings from a polycarbonate substrate of a compact disc, the method comprising:

(a) immersing a batch of compact discs in an alkaline solution;

(b) heating said alkaline solution to a predetermined temperature;

(c) mechanically agitating said immersed discs by applying to said heated alkaline solution ultrasonic energy with a predetermined energy density, the alkaline solution being at a sufficient concentration and temperature and in contact with the agitated discs for a time sufficient to dissolve the lacquer and aluminium coatings into solution and to leave behind the stripped polycarbonate discs;

(d) washing the stripped polycarbonate discs to remove remanent alkaline solution therefrom; and

(e) drying the washed polycarbonate discs.

Preferred embodiments of the invention described below provide:

a process for removing the coatings from the polycarbonate substrates of compact discs so as to reclaim the polycarbonate; and

a process for treating compact discs to remove the coatings from their polycarbonate substrates that will free the protective lacquer coating regardless of its type.

The invention will now be further described by way of illustrative and non-limiting example.

The inventor has found, surprisingly, that it is possible to strip the protective lacquer layer, whether UV-cured or solvent-based, and the underlying aluminium film, from the polycarbonate substrate of compact discs, without causing dissolution of the polycarbonate, by placing a quantity of the discs in a perforated barrel supported for rotation in an ultrasonic tank containing an aqueous alkaline solution of an alkaline salt or a base, a chelating additive and a surfactant, and as the barrel is rotated agitating the discs with ultrasonic energy for a time sufficient to completely remove the coatings from the substrate. The long axis of rotation of the barrel is disposed horizontally, and the barrel, which typically may be 406 mm (16 inches) in diameter and 508 mm (20 inches) long, has round openings or holes, 76 to 102 mm (3 to 4 inches) in diameter, in its walls to facilitate flow of the solution to and from the interior of the barrel and floating of removed flakes of lacquer out of the barrel for settling onto the bottom of the tank. Any desired number of discs, up to capacity of the barrel, are loaded into the barrel.

The tank in which the barrel is supported is filled with an aqueous alkaline solution containing: (1) an alkaline salt or a base which preferably is a mixture of alkali metal phosphate, alkali metal hydroxide and alkali metal carbonate, wherein the metal may be either sodium or potassium; (2) a chelating additive selected from the alkali metal salts of citric acid, ethylenediamine tetraacetic acid (EDTA), gluconic acid and nitrilotriacetic acid; and (3) a wetting agent selected from the group including sodium alkybenzenesulphonates, naphthalenesulphonates, fatty acid esters and sodiumlaurylsulphate. Following is a working alkaline composition range for the three basic constituents:

alkaline salt or a base - 30 to 500 g/l (grams per litre);

chelating additive - 0.5 to 100 g/l; and

wetting agent - 0.5 to 10 g/l.

The preferred composition range is: alkaline salt - 50 to 200 g/l; chelating additive - 5 to 50 g/l; and wetting agent - 1 to 5 g/l.

The alkaline solution is heated to a temperature in the range from about 54°C (130°F) to about 104°C (220°F) and the barrel is rotated about its horizontal axis at a speed preferably in the range from 60 revolutions per minute (rpm) to 100 rpm, so as to cause significant turbulence in the solution passing over the discs contained in the barrel. At the same time, the barrel is oscillated in the vertical direction at about one cycle/second with a displacement of about 152 mm (6 inches), for additionally agitating the contained discs. The advantageous results of the process of stripping the lacquer coating are achieved in large part by applying to the alkaline solution ultrasonic energy at a frequency in the range from about 20 kHz to about 40 kHz at a power level consistent with the amount of material in the barrel; typically the power level may be in the range from about 10 to about 200 watts per litre of solution contained in the tank. It has been determined that barrel rotation speeds as low as 10 rpm can be used, and that the faster the speed of rotation the faster the rate at which the coatings are stripped from the substrate. Within the operational limits of the supporting structure and mechanism for rotating the barrel, acceptable results are obtainable at rotational speeds in the range from about 10 rpm to about 200 rpm, a range of about 60 to 100 rpm being preferred for a barrel of the size indicated. The barrel is rotated and agitated for a time sufficient to flake off or dissolve the lacquer and dissolve into the solution the aluminium coatings from all discs of the batch which may take from about 1.5 to 2 hours for a fully loaded barrel of the size indicated immersed in an alkaline solution at a concentration and a temperature within the ranges indicated. The time required will vary with the frequency and power level of the ultrasonic energy, the speed of rotation of the barrel and other parameters such as solution concentration and temperature.

A process embodying the invention as described above will remove both of the lacquers commonly used today in manufacturing compact discs; accordingly, if a batch of discs loaded into the barrel happens to be a mixture of some having UV-cured lacquer coating and others having a solvent-based lacquer coating, both kinds will be dissolved at the same time without any adjustment in the process.

After the coatings have been stripped from all discs of the batch contained in the barrel, the alkaline solution along with the flaked and/or dissolved lacquer and dissolved aluminium is decanted from the barrel, leaving behind the stripped polycarbonate discs. The stripped discs are then washed with water, preferably at a temperature in the range from about 38°C (100°F) to about 99°C (210°F), to remove remanent caustic solution from the discs. Following washing, the discs are dried in a suitable hot air dryer, such as the Hot Air Dryer manufactured and sold by Branson Ultrasonic Corporation, Danbury, Connecticut, USA, at a temperature in the range from about 38°C (100°F) to about 99°C (210°F). The time required for rinsing and drying a barrel of discs is about fifteen minutes.

Examples of processes embodying the invention will now be set forth.

Example 1

Compact discs having a protective lacquer coating over an aluminium coating were placed in a barrel having a volume of 2 litres which was rotated at 60 rpm in a tank containing 20 litres of an aqueous solution of sodium hydroxide, sodium phosphate and sodium carbonate at concentrations of 100 g/l, 50 g/l and 25 g/l, respectively, sodium laurylsulphate at a concentration sufficient to keep the surface tension of the solution in a range from 40 to 50 dynes/cm, typically 1 g/l, the solution was heated to a temperature of 82°C (180°F) and subjected to one kilowatt of ultrasonic energy at a frequency of 20 kHz. The lacquer coating was stripped, and the aluminium coating dissolved, in about one hour.

Example 2

A batch of scrap compact discs was placed in a barrel having a volume of 15 litres which was immersed and rotated at 60 rpm in a tank containing 100 litres of an aqueous solution of sodium hydroxide, sodium carbonate, sodium tripolyphosphate and sodium laurylphosphate at concentrations of 100 g/l, 50 g/l, 25 g/l and 1.5 g/l, respectively, the solution was heated to a temperature of 71°C (160°F) and subjected to 4 kilowatts of ultrasonic energy at a frequency of 20 kHz. The lacquer coating was stripped and the aluminium coating dissolved, in about 1.5 hours. Similar results were observed when potassium hydroxide was used as the alkaline salt instead of sodium hydroxide.

Example 3

A batch of scrap compact discs was placed in a barrel having a volume of 20 litres which was immersed and rotated at 30 rpm in a tank containing 125 litres of an aqueous solution of potassium hydroxide, sodium carbonate, tetrasodium phosphate, EDTA and naphthalenesulphonate at concentrations of 50 g/l, 50 g/l, 50 g/l, 5 g/l and 5 g/l, respectively, the solution was heated to 71°C (160°F) and subjected to 8 kilowatts of ultrasonic energy at 40 kHz. The lacquer coating was stripped and the aluminium coating dissolved in about 2 hours.

While several alkaline solutions having different compositions have been described, and preferred ranges of concentrations of each constituent indicated, the process will work with any alkaline solution having a pH of about 13 and above. For practical purposes, the chemicals used and their concentrations should be such that the reaction between the alkaline solution and the lacquer and the aluminium proceeds at a rate deemed desirable by the practitioner of the method. Similarly, the speed of rotation of the barrel, the temperature to which the solution is heated, and the amount and frequency of the applied ultrasonic energy are such that the combined chemical reaction and mechanical agitation cause the stripping action to proceed at a rate deemed desirable by the practitioner.

Claims

1. A method for removing lacquer and aluminium coatings from a polycarbonate substrate of a compact disc, the method comprising:
   (a) immersing a batch of compact discs in an alkaline solution;
   (b) heating said alkaline solution to a predetermined temperature;
   (c) mechanically agitating said immersed discs by applying to said heated alkaline solution ultrasonic energy with a predetermined energy density, the alkaline solution being at a sufficient concentration and temperature and in contact with the agitated discs for a time sufficient to dissolve the lacquer and aluminium coatings into solution and to leave behind the stripped polycarbonate discs;
   (d) washing the stripped polycarbonate discs to remove remanent alkaline solution therefrom; and
   (e) drying the washed polycarbonate discs.

2. A method according to claim 1, wherein said batch of compact discs comprises compact discs coated with a solvent based lacquer coating and/or compact discs coated with a UV-cured acrylic lacquer coating.

3. A method according to claim 1 or claim 2, wherein the alkaline solution is at a pH of about 13 or more.

4. A method according to claim 1, claim 2 or claim 3, wherein said alkaline solution is an aqueous solution of an alkaline salt or a base, a chelating additive and a wetting agent.

5. A method according to claim 4, wherein said alkaline solution is an aqueous solution of:
   an alkali metal phosphate, alkali metal hydroxide or an alkali metal carbonate, wherein the metal is sodium or potassium, as an alkaline salt or a base;
   an alkali metal salt of citric acid, ethylenediamine tetraacetic acid (EDTA), gluconic acid or nitrilotriacetic acid as a chelating agent; and
   a wetting agent selected from the group including sodium alkylbenzenesulphonates, naphthalenesulphonates, fatty acid esters and sodiumlaurylsulphate.

6. A method according to claim 5, wherein, in said alkaline solution, said alkaline salt or a base has a concentration in the range from about 30 to about 500 g/l, said chelating agent has a concentration in the range from about 0.5 to about 100 g/l and said wetting agent has a concentration in the range from about 0.5 to about 10 g/l.

7. A method according to claim 6, wherein, in said alkaline solution, said alkaline salt or a base has a concentration in the range from 60 to 200 g/l, said chelating agent has a concentration in the range from 5 to 50 g/l and said wetting agent has a concentration in the range from 1.0 to 5 g/l.

8. A method according to any one of the preceding claims, wherein said alkaline solution is contained in a tank, said batch of discs is contained in a rotatable perforate barrel which is immersed in the alkaline solution, and said barrel is rotated at a speed in the range from about 10 rpm to about 200 rpm.

9. A method according to claim 8, wherein said barrel is rotated at a speed in the range from about 60 rpm to about 100 rpm.

10. A method according to any one of the preceding claims, wherein said discs are agitated by applying to said alkaline solution ultrasonic energy having a frequency in the range from about 20 to about 40 kHz with an energy density in the range from about 10 to about 200 watts per litre.

11. A method according to any one of the preceding claims, wherein the stripped polycarbonate discs are washed in water having a temperature in the range from 38 to 99°C (100 to 210°F), and the washed polycarbonate discs are air dried at a temperature in the range from 38 to 99°C (100 to 210°F).

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EUROPEAN SEARCH REPORT

Application Number
EP 93 30 9098

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
Y,P	WO-A-94 01491 (HELVEREP S. A.) 20 January 1994 * claims *	1-3	C08J11/06 G11B33/04 C09D9/04 //(C08J11/06, C08L69:00)
Y	CHEMICAL ABSTRACTS, vol. 110, no. 10, 6 March 1989, Columbus, Ohio, US; abstract no. 78754h, 'Recovery of magnetic powder from used magnetic recording medium' * abstract * & JP-A-63 201 018 (...)	1-3	
A	DD-A-284 477 (FORSCHUNGSINSTITUT FÜR TEXTILTECHNOLOGIE.) * claims *	1-11	

TECHNICAL FIELDS SEARCHED (Int.Cl.5)

C08J
C09D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	17 March 1994	Oudot, R

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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D : document cited in the application
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